Claims

What is claimed is:

1. A heart valve prosthesis comprising:

a generally cylindrical support extending between opposed ends thereof, a plurality of support features extend generally axially between the opposed ends of the support and are interconnected so as to bias the support radially outwardly; and

a valve mounted within the support to define a supported valve, the supported valve being deformable between a first condition a second condition, the supported valve having a cross-sectional dimension in the second condition that is less than a cross-sectional dimension of the supported valve when in first condition, whereby implantation of the supported valve is facilitated when in the second condition.

2. The prosthesis of claim 1, further comprising biasing elements that interconnect at least some of the support features, each biasing element urging support features that are interconnected by respective biasing element apart from each other.

3. The prosthesis of claim 2, the biasing elements further comprising springs arranged in a generally circular array at the opposed ends of the support, the springs interconnecting adjacent support features to bias the support radially outwardly.

4. The prosthesis of claim 3, the support features and the springs being formed of a continuous length of a resilient material to provide a cage-like support.

5. The prosthesis of claim 3, further comprising projections biased to extend radially outwardly from at least one of the opposed ends.

6. The prosthesis of claim 5, the projections further comprising a set of triangular projections interconnected at the opposed ends by biasing elements that orient the triangular projections to extend axially and radially outwardly from the respective opposed ends.

7. The prosthesis of claim 1, further comprising a flexible connecting element attached to the support to inhibit radial outward expansion of at least part of the support beyond a predetermined amount.

8. The prosthesis of claim 7, the connecting element further comprising a loop of a flexible cord.

9. The prosthesis of claim 7, further comprising a loop of a flexible material connected to the support at each of the opposed ends to inhibit radial outward expansion of the support at the opposed ends beyond a predetermined amount.

10. The prosthesis of claim 1, the support further comprising at least two generally cylindrical support portions having adjacent ends connected substantially coaxially together, the support portions also having respective spaced apart ends that define the axially opposed ends of the support, the valve including an inflow end and an outflow end spaced apart from each other on axially opposed sides of a juncture between the support portions.

11. The prosthesis of claim 10, further comprising an intermediate connecting element that connects the support portions at the juncture between the support portions.

12. The prosthesis of claim 10, each of the support portions having a sidewall portion comprising a plurality of elongated support features that extend generally axially between the ends of each respective support portion in a

circumferential arrangement, the support features of each support portion being interconnected so as to bias each respective sidewall portion and the valve mounted therein radially outwardly.

13. The prosthesis of claim 12, further comprising a plurality of biasing elements that interconnect adjacent support features in each of the support portions, the biasing elements urging the interconnected support features apart from each other to provide radial outward expansion of the respective sidewall portions.

14. The prosthesis of claim 13, the biasing elements being connected by flexible connecting elements in a generally circular arrangement at the ends of each respective support portion, the connecting elements inhibiting radial expansion of at the respective ends of the support portions beyond a predetermined amount.

15. The prosthesis of claim 12, further comprising projections biased to extend radially outwardly from the axially opposed ends of the support.

16. The prosthesis of claim 14, the projections further comprising a set of triangular projections connected at each of the opposed ends by biasing elements that bias the triangular projections to extend axially and radially outwardly from the respective opposed ends.

17. The prosthesis of claim 1, further comprising an outer sheath of a substantially biocompatible that covers at least a substantial portion of the exposed part of the support.

18. The prosthesis of claim 1 in combination with an implanter, the combination comprising:

the implanter including an elongated cylindrical enclosure dimensioned and configured to receive the prosthesis when in the second condition; and

the prosthesis being disposed within the cylindrical enclosure, such that an inner sidewall of the cylindrical enclosure maintains the prosthesis in the second condition.

19. The combination of claim 18, the implanter further comprising a plunger operative to move within the cylindrical enclosure and urge the prosthesis out of the cylindrical enclosure, the support being operative to expand the prosthesis from the second condition to the first condition when discharged from the cylindrical enclosure.

20. An implantation system, comprising:

an elongated cylindrical member having spaced apart ends, at least one of the ends providing an opening;

a heart valve prosthesis including a generally cylindrical support having axially spaced apart ends, a valve mounted within the support at a fixed axial position between the spaced apart ends of the support, the prosthesis being deformable to a first condition in which the prosthesis has a reduced cross-sectional dimension, the support being biased to expand the prosthesis radially outwardly from the first condition to a second condition in which the prosthesis has a cross-sectional dimension that greater than reduced cross-sectional dimension, the prosthesis being mounted within the cylindrical member in the first condition; and

a plunger operative traverse at least part of the cylindrical member and urge the prosthesis from the cylindrical member through the opening.

21. The system of claim 20, the support being formed of a shape memory alloy operative to urge the prosthesis to the second condition.

22. The system of claim 20, the support further comprising a plurality of elongated support features that extend generally axially between ends of the support, biasing elements interconnecting adjacent support features in a circumscribing relationship around the valve, the biasing elements urging the

interconnected adjacent support features apart from each other, so as to urge the prosthesis toward the second condition.

23. The system of claim 22, further comprising at least one connecting element operative to hold the biasing elements in a generally circular array and to limit the radial outward expansion of the prosthesis at the location of the circular array.

24. The system of claim 22, further comprising a plurality of resilient projections that extend radially outwardly from the axially opposed ends of the support.

25. The system of claim 24, the projections further comprising a set of triangular projections attached to each of the opposed ends of the support by biasing elements that bias the triangular projections to extend axially and radially outwardly from each of the respective opposed ends of the support.

26. The system of claim 22, the support features and the biasing elements being formed of a continuous length of a substantially resilient and elastic material that facilitates expansion of the prosthesis from the first condition to the second condition.

27. The system of claim 20, further comprising an outer sheath of a substantially biocompatible that covers at least a substantial portion of an exposed part of the support.

28. The system of claim 20 wherein the valve further comprises an animal heart valve.

29. A method for implanting a heart valve prosthesis into a patient's heart, the method comprising:

inserting the heart valve prosthesis into a generally cylindrical enclosure of an implanter, such that the prosthesis has a reduced cross-sectional dimension relative to a fully expanded cross-sectional dimension of the prosthesis;

opening a patient's chest;

creating an opening in a blood vessel that provides a substantially direct path to the patient's heart;

passing a length of the cylindrical enclosure through the opening to position an end of the implanter at a desired position in the patient;

discharging the heart valve prosthesis from the cylindrical enclosure of the implanter; and

expanding the heart valve prosthesis at the desired position from the reduced cross-sectional dimension toward the expanded cross-sectional dimension, such that an exterior portion of the heart valve prosthesis engages adjacent tissue to mitigate axial movement of the prosthesis relative to the adjacent tissue.

30. The method of claim 29, the expanding occurring automatically in response to removal of the heart valve prosthesis from the cylindrical enclosure.

31. The method of claim 29 occuring in the absence of caridiopulmonary bypass.

32. The method of claim 29, the blood vessel further providing a generally linear path to the patient's heart.

33. The method of claim 32, the blood vessel being the patient's pulmonary artery.

34. The method of claim 29, further comprising urging a portion of the blood vessel that surrounds the opening into engagement with part of the implanter to mitigate blood loss through the opening.

35. The method of claim 34, the urging further comprising applying a purse string around the opening and tightening the purse string around an adjacent part of the implanter at the opening to mitigate the blood loss through the opening.

36. The method of claim 29, the heart valve prosthesis further comprising a generally cylindrical support extending between opposed ends thereof, a plurality of elongated support features extending generally axially between the opposed ends of the support, the support features being interconnected so as to bias a sidewall of the support radially outwardly to the expanded cross-sectional dimension, a tissue valve mounted within the support so as to radially expand commensurately with the support.

37. The method of claim 36, the support further comprising a generally circular array of biasing elements at each end of the support that interconnect adjacent support features and urge the interconnected adjacent support features apart from each other.

38. The method of claim 36, the support further comprising a set of projections interconnected at each of the opposed ends of the support and biased to extend axially and radially outwardly from the opposed ends, the projections engaging adjacent tissue after the heart valve prosthesis expands to the expanded cross-sectional dimension to help anchor the prosthesis relative to the patient's heart.

39. The method of claim 29, further comprising attaching a length of at least one suture to the prosthesis and, after discharging the prosthesis, using the at least one suture to adjust the relative position of the prosthesis.

40. A method for implanting a heart valve prosthesis into a patient's heart, the method comprising:

inserting the heart valve prosthesis into a generally cylindrical and elongated enclosure, such that the prosthesis has a reduced cross-sectional dimension corresponding to a dimension of the cylindrical enclosure, the prosthesis being biased to self-expand from the reduced cross-sectional dimension to an expanded cross-sectional dimension, which is greater than the reduced cross-sectional dimension;

creating an opening in a blood vessel that provides a generally linear path to the patient's heart;

passing an open end of the cylindrical enclosure through the opening;

positioning the open end of the cylindrical enclosure at a desired position in the patient's heart;

discharging the heart valve prosthesis from the cylindrical enclosure, whereupon the heart valve prosthesis expands from the reduced cross-sectional dimension to an expanded cross-sectional dimension, such that an exterior portion of the heart valve prosthesis engages adjacent tissue to mitigate axial movement of the prosthesis relative to the adjacent tissue.

41. The method of claim 40, the cylindrical enclosure being part of a generally rigid and substantially linear implanter apparatus.

42. The method of claim 40, the blood vessel being the patient's pulmonary artery.

43. The method of claim 40, further comprising urging an adjacent part of the blood vessel that surrounds the opening into engagement with part of the cylindrical enclosure to mitigate blood loss through the opening.

44. The method of claim 43, the urging further comprising applying a purse string around the adjacent part of the blood vessel that surrounds the opening and tightening the purse string around part of the cylindrical enclosure to mitigate the blood loss through the opening.

45. The method of claim 40, further comprising attaching a length of at least one suture to the prosthesis and, after discharging the prosthesis, using the at least one suture, part of which extends from the heart valve prosthesis through the opening, to adjust the relative position of the prosthesis.

46. A method for implanting a heart valve prosthesis, comprising:

creating an opening in a blood vessel that provides a generally linear path to a patient's heart;

passing a length of a generally cylindrical barrel through the opening to position an end of a implanter at a desired position in the patient's heart, an expandable heart valve prosthesis being located within the barrel; and

discharging the heart valve prosthesis from the barrel to a desired position in the patient's heart so that the discharged valve expands to an expanded cross sectional dimension that contacts adjacent tissue in the patient's heart to mitigate movement of the heart valve prosthesis relative to the patient's heart.

47. The method of claim 46, further comprising, after discharging the heart valve prosthesis, using at least one suture, which extends from the prosthesis through the opening, to adjust the relative position of the prosthesis.